

Foundations of Information Systems

Mock Exam

January 27, 2025

1. (a) Derive a Boolean algebra expression for the following binary truth table:

a	b	c	z
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

- (b) Simplify your expression as much as possible.
(c) Draw a circuit diagram representing your (possibly simplified) expression.

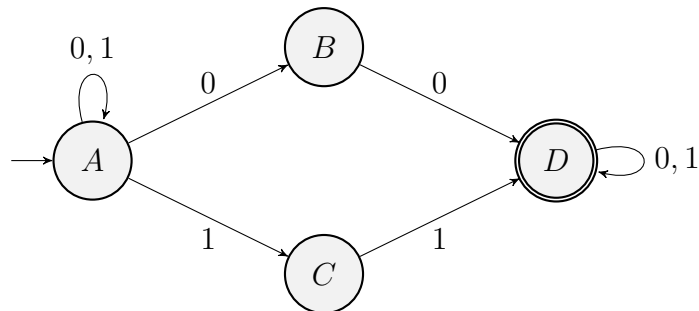
(5+5+5)

2. Show your work when answering the following questions.

- (a) Convert $(17.75)_{10}$ into binary.
(b) Convert $(A1.C)_{16}$ into decimal.
(c) Which integer is represented by the bit pattern 11110101 interpreted in 8-bit two's complement representation?

(5+5+5)

3. Consider the following non-deterministic FSA:



- (a) Is the input string 01001 accepted? Show the possible transitions of the FSA step-by-step.
- (b) What strings does this FSA accept? Answer in words and state a corresponding regular expression.
- (c) Convert this non-deterministic FSA into an equivalent deterministic FSA.

(5+5+5)

4. Are the following statements true or false? If true, give a *brief* explanation. If false, correct or amend the statement so that it is true.

- (a) Starvation implies deadlock.
- (b) Deadlock can only occur if processes are in circular waiting.
- (c) Deadlock may occur when several processes compete for a single mutually exclusive resource.
- (d) Imposing a total ordering on resource acquisition can prevent deadlocks.
- (e) Using a smaller page size increases the size of the page tables.

(2+2+2+2+2)

5. You are asked to set up a RAID array with four 2 TB disks. Usable capacity of the entire array must be at least 4 TB. You ponder the options RAID 5, RAID 6 and RAID 10.

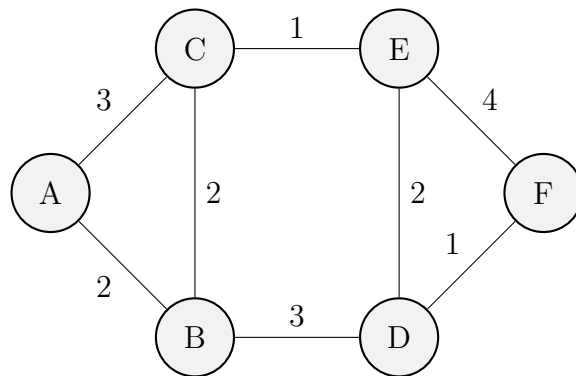
- (a) Compare the three options in the categories usable capacity, speed of small random writes, and data integrity in case of a drive failure.
- (b) Make a recommendation. If no option is superior in all respects, state a use case that would favor each.

(5+5)

6. (a) Encode the data word 1110 as a Hamming (7,4) encoded message. Use the bit ordering convention from class.
- (b) You want to encode a stream of data bytes (1 byte = 8 bits) such that each byte to be encoded corresponds to exactly two bytes in the encoded message stream. What are your options within the Hamming (n, k) -family of codes? Explain your preferred choice.

(5+5)

7. Consider the following router network:



Use Dijkstra's algorithm to compute the shortest path from router A to every other router in the network. (10)